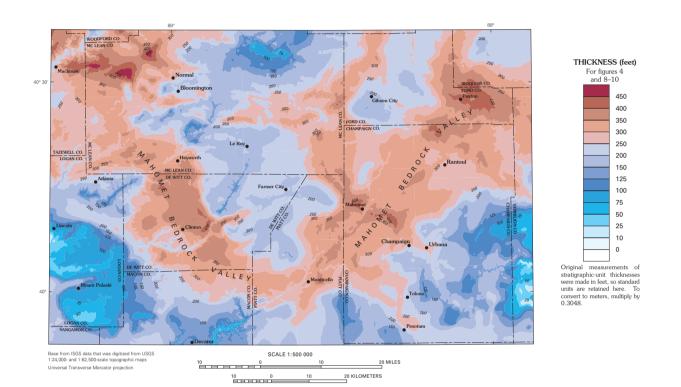


Figure 3.—Perspective view, looking north, showing surficial geology and buried Quaternary units in the map area. Surficial geology is from Lineback (1979) and Stiff (1996); the latter is a digital version of the map by Hansel and Johnson (1996). Subsurface geology is from this study, and is shown in more detail on sheet 2; subsurface units are the same as those shown in figure 7. Bedrock is shown in gray. In the southwestern part of the map area, the Upper Glasford Formation is covered in places by younger deposits, which for modeling purposes are assumed to be 15 ft thick (see discussion under "An internally consistent geologic model and set of maps," fourth paragraph). Black line shows the southwesternmost limit of Wedron Group deposits. Topography is from edited, digital versions of USGS 1:100,000-scale topographic maps. Image is vertically exaggerated approximately 30x.



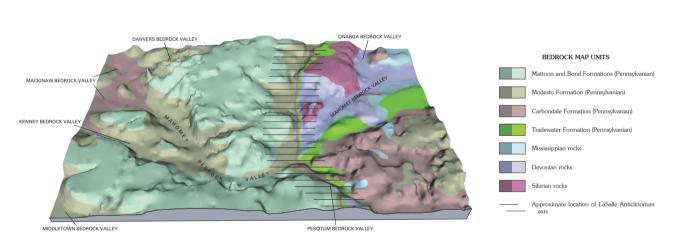


Figure 4.—Thickness of glacial sediments, including minor overlying sediments of nonglacial origin. Sediments over-lie a bedrock surface of moderate relief; thicker sediments occur in the Mahomet Bedrock Valley and beneath Wedron Group end moraines (fig. 3), and somewhat thinner sediments occur on the bedrock uplands. The Mahomet Bedrock Valley is a preglacial and early glacial drainage system in the region (see Kempton and others, 1991)

Figure 5.—Perspective view, looking north, of the geology and topography of the bedrock surface in the map area. Bedrock geology is from Pius Weibel (Illinois State Geological Survey (ISCS), written commun., 1997). Bedrock topography is from this study. The axis of the LaSalle Anticlinorthm, of late Paleozoic age, also is shown. To enhance topographic detail, the image is vertically exaggerated approximately 30x.

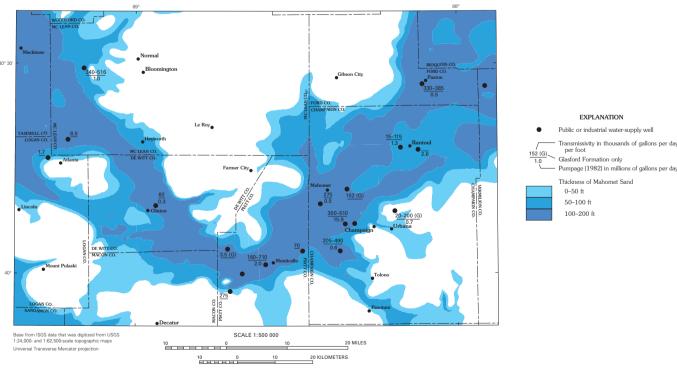


Figure 6.—Representative hydrologic properties of municipal and industrial wells developed in the Mahomet Sand and Glasford Formation aquifers (modified from Kempton and others, 1991, fig. 23).

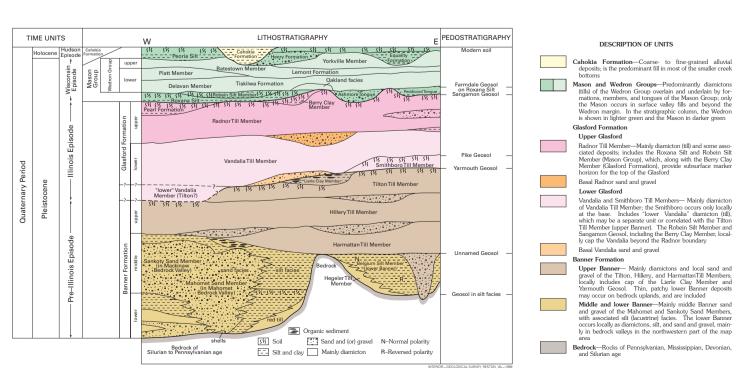


Figure 7.—Diagrammatic stratigraphic column of glaciogenic sediments in east-central Illinois. The Cahokia Formation was deposited mostly during the Hudson Episode. Geologic and stratigraphic names and intervals used in this figure are those accepted by the ISGS.

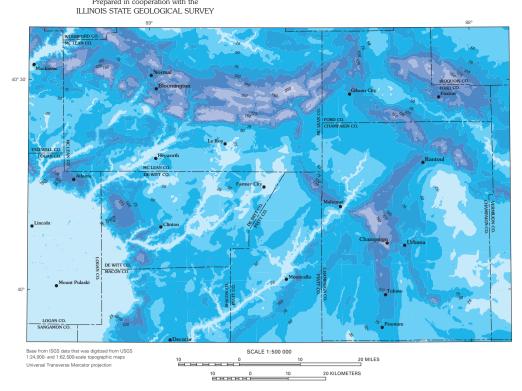


Figure 8.—Thickness of the Wedron and Mason Groups (Wisconsin Episode); includes minor thickness of the Cahokia Formation (Wisconsin and Hudson Episodes) as alluvial fill in the valleys and the Peoria Silt as loess on the Cahokia Formation (Wisconsin and Hudson Episodes) as alluvial fill in the valleys and the Peoria Silt as loses on the uplands. Arrcuate bands of thicker sediment correspond to end moraines (see fig. 3), where glacial ice stagnated. Sinuous areas of thin sediment correspond to modern river valleys, where the Wedron and Mason Group deposits have been eroded (for example, the valleys of the Sangamon River and Salt Creek). The southwestern part of the map area lies beyond the limit of Wedron Group deposits. There, only thin, discontinuous Cahokia Formation and Mason Group deposits occur, mostly as alluvium, outwash, and loess; to permit them and the underlying units to be mapped efficiently by computer, a uniform thickness of 15 ft was assumed (see discussion under "An internally consistent geologic model and set of maps," fourth paragraph).

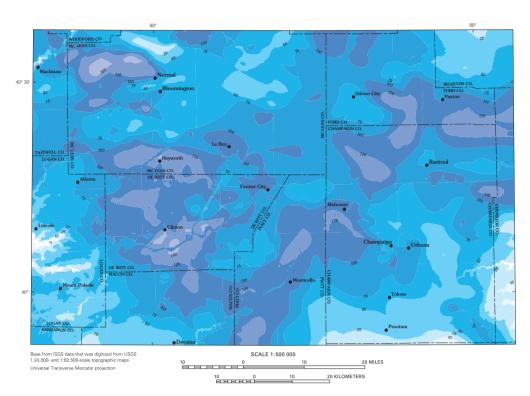


Figure 9.—Thickness of the Glasford Formation (Illinois Episode). The pattern of sediment deposition was affected by the Mahomet Bedrock Valley, which had been partly filled by older sediment. Areas of thicker sediment mostly correspond to this ancient valley. Simuous areas of thinner sediment correspond to modern rivalleys, where the Glasford Formation has been partly or completely eroded (for example, the valleys of the Sangamon River and

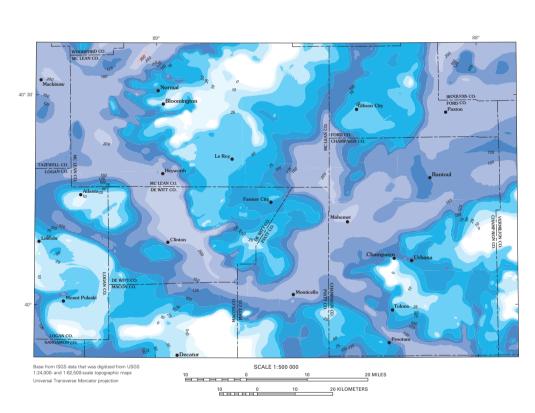


Figure 10.—Thickness of the Banner Formation (pre-Illinois Episode). The pattern of sediment deposition was greatly influenced by the Mahomet Bedrock Valley. The fluvial phase of these sediments constitutes the thickest part of the section and delineates the valley and its tributaries. These mostly sand and gravel sediments are overlain by diamictions, which occur in the valley and on the surrounding bedrock uplands. In many areas, especially on the bedrock uplands, the Banner Formation was eroded by later glaciations or fluvial action.

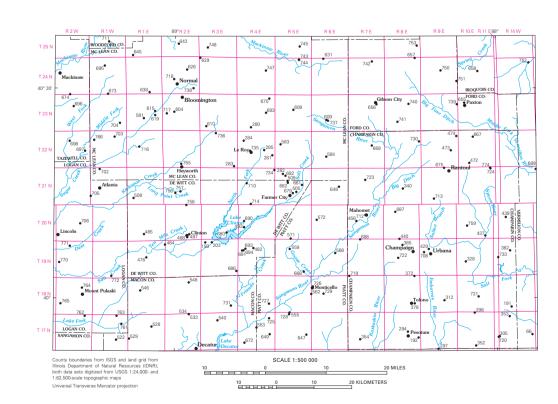


Figure 11.—Location of 167 of the 177 key stratigraphic control points used in this study (10 occur outside the map area). They are high-quality data points at verified locations, derived from the ISGS collection of subsurface information. These data are in the form of continuous core samples from test borings, drill cuttings and washed "grab" samples from water wells, drillers' logs, geophysical logs, and, rarely, outcrops. In addition to the key stratigraphic control points, many more well data were used in the preparation of the maps shown in this report.

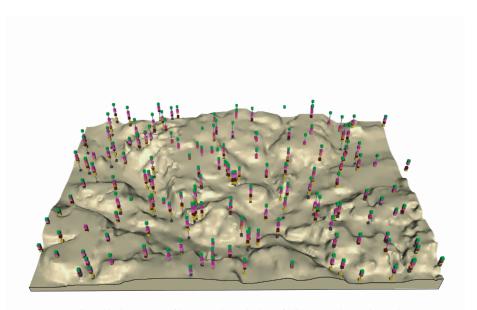


Figure 12.—Perspective view of the map area showing distribution of 167 key stratigraphic control points relative to the bedrock topographic surface. Viewpoint is from the south. Each control point is represented by a linked, vertical sequence of colored cubes. The top of each cube represents the top of a stratigraphic unit, as follows: green, land surface; magenta, upper Glasford Formation; pink, lower Glasford Formation; orange, Glasford Formation sands; brown, upper Banner Formation; yellow, middle Banner Formation; and black, bedrock. Cube thickness does not imply unit thickness. To show topographic detail, the image is vertically exaggerated approximately 30x.

DISCUSSION

INTRODUCTION

This geologic mapping project was conducted society by the Illinois State Geological Survey (ISGS) and the U.S. Geological Survey (USGS) to map the Quaternary deposits in east-central Illinois (figs. 1 and 2). This area provides an excelent geologic esting to develop and test new techniques for mapping Quaternary deposits in three dimensions (that is, mapping the thickness and distribution of geologic materials both at the land surface and in the subsurface) because it has diverse Quaternary geology and thick, regional sand and gravel aquifers within a buried bedrock valley system, the Mahomet Bedrock Valley (figs. 3–5). Decades ago, this valley commonly had been considered part of the Teays River system, a proposed westward-flowing drainage system formed during preglacial and glacial times, which was thought to extend across Illinois, Indiana, and Ohio, to West Virginia. Modern evidence, however, suggests the Mahomet Bedrock Valley is a local drainage system in western Indiana and eastern Illinois that formed during early glaciations through alteration of the preglacial drainage patterns (Melhorn and Kempton, 1991).

The total glacial drift succession is locally thicker than 500 ft in the Mahomet Bedrock Valley, whereas the bedrock uplands are covered by 50 to 300 ft of glacial sediments (fig. 4). Glacial deposits overlie Paleozoic bedrock ranging in age from Silurian to Pennsylvanian. Transmissivity and water quality vary among the bedrock units. Through leakage upward into the Mahomet Sand quifer, the bedrock units have some effect on its water quality, and should be considered in the modeling and management of ground-water resources (Panno and others, 1994). Figure 5 prominently shows the Mahomet Bedrock Valley incised into the bedrock surface; it also shows the axis of the LaSalle Anticlinorium near the center of the map area. Across this major north-south-trending structure, the Mahomet Bedrock valley changes course: the shows the Mahomet Bedrock Valley incised into the bedrock surface; it also shows the axis of the LaSale Anticlinorium near the center of the map area. Across this major north-south-trending structure, the Mahomet Bedrock Valley changes course; the upwalley part (to the east) is oriented northeast-southwest whereas the downvalley part (to the west) is oriented southeast-southwest. The map area also contains some of the oldest glacial sediments identified in the region, including a complex sequence of diamictons and sands and gravels associated with multiple glaciations and buried soils associated with interglaciations. A diamicton is a mixture of clay, slit, sand, gravel, and boulders that, if of glacial origin, is commonly referred to as till, although most of the diamictons in the map area are interpreted as till, we use diamicton, the more general descriptor. However, the term "till" is retained where it is part of the stratigraphic

name of a unit.

In past studies, various surface and subsurface mapping techniques have been applied to all or parts of the map area. These include an ISGS statewide stack-unit map (Berg and Kempton, 1988), which shows the succession of geologic materials in their order of occurrence to a depth of 50 ft, and a small-scale (1:1,000,000) USGS map of thickness and character of Quaternary deposits (Soller, 1993, 1998). Detailed geographic information system (GIS) techniques (Berg and Abert, 1994, and McLean and others, 1997) have also been developed for the region. This part of east-central Illinois provides an excellent opportunity to test and develop new concepts and procedures for portraying geologic materials in three dimensions, for possible use in future dures for portraying geologic materials in three dimensions, for possible use in future state and national mapping programs.

This study was conducted in a ground-water-rich area of the State, where delineation of sand and gravel aquifers is essential to better understand resource potentials, to resolve conflicts over ground-water use, to support planning for ground-water protection strategies, and to support regional economic growth. Previous studies by Horberg (1945, 1953), and Kempton and others (1991) increased our understanding of the Quaternary deposits. However, since then, available subsurface data have improved, models of regional geologic history have been refined, and the public's need for more precise information has increased. Consequently, existing maps have become outdated. New maps can supply societal benefits not realized by pre-existing ones (for example, see Bernknopf and others (1993) and Soller and Bernknopf (1994)]. A significantly updated database of subsurface information and newly developed methods that incorporate digital mapping techniques have allowed us to provide updated maps based on an improved understanding of the regional geology.

This report comprises three sheets. Figures 1–12 are shown on sheet 1, figures 13–16 are on sheet 2, and figures 17–19 are on sheet 3.

ACKNOWLEDGMENTS These maps are the product of a cooperative project supported by the ISGS and the USGS. We thank Bill Shilts (ISGS Chief and State Geologist) and John Pallister (Program Coordinator, USGS National Cooperative Geologist (Mapping Program) for fostering the cooperative environment needed to conduct the project. We particularly wish to thank (Mary Mushrush (ISGS) for many weeks of work in helping to develop the database for the mapping. We also thank Plus Weibel (ISGS) for providing the map of bedrock geology, and James Estabrook and Paul Mathieux (both USGS) for their skill-ful and timely work on map editing and graphic design. The quality of the maps and text were improved by thoughtful reviews provided by Ardith Hansel, Robert Krumm, and Don Méckay (all ISGS), and Cark Koteff (USGS). and Don McKay (all ISGS), and Carl Koteff (USGS).



cussing area's geologic history and resour (locality 774, section 1, T. 21 N., R. 10 E.).

REGIONAL GROUND-WATER RESOURCES Ground water within sand and gravel of the buried Mahomet Bedrock Valley aquifer system has been estimated by the Illinois State Water Survey (Vlsocky and Schicht, 1969) to be able to provide about 445 million gallons per day (mgd) to large municipalities, industry, and private residences. Figure 6 shows representative data from water-well records. Even during the drought of 1988, however, only about 85 mgd

vere used, which was the maximum yearly usage (Illinois State Water Plan Task Force ISWPTF], 1997). Therefore, the resource potential of the aquifer system is quite large.

The Mahomet Sand, which fills the deepest parts of the bedrock valley, is the thickest and most widespread aquifer in the system. In addition, overlying the Mahomet Sand are sand and gravel units intercalated with fine-grained sediment. Where the Mahomet Sand is absent, these aquifers are important sources of water for farmsteads, communities, and industries. They also hold water for gradual recharge into the underlying Mahomet Sand Aquifer (SWPTF, 1997).

The Mahomet Bedrock Valley was defined first by Leland Horberg in 1945. Since The Mahomet Bedrock Valley was defined first by Leland Horberg in 1945. Since then, the bedrock valley and its sand and gravel acquifers have been the subject of considerable interest by scientists, planners, State and local regulatory agencies, the agricultural and industrial community, and the general public. The ISWPIT (1997) reported that increased water use and recent droughts have caused concern about long-term use of the region's aquifers. They noted that the drought of 1988 significantly affect-disurface-water reservoirs that supply water for the cities of Decatur, Danville, and Bloomington (fig. 1). Potential additional development of the Mahomet Sand Aquifer to supplement these surface water supplies could amount to about 20 to 30 mgd. Of concern is the continued growth in the Champaign-Urbana area (whose wells are the largest system tapping the aquifers) and dependence on the aquifers as the primary supply to many smaller communities. Other users of the ground-suder symbly have largest system tapping the aquifers) and dependence on the aquifers as the primary supply to many smaller communities. Other users of the ground-water supply have increased in number and in demand and are expected to continue to increase. The number of irrigation systems has expanded and there have been increased industrial activities such as the production of ethanol, which requires large volumes of water. Because resource development is expected to increase, many communities have sought to control ground-water resource development near their wells and well fields, and local water authorities have been established. However, as the ISWPTF (1997) states, "The desire to unduly or unfairly restrict or control ground-water resource development generally stems from a lack of information about the resources or from a fear of becoming economically disadvantaged due to unknown adverse impacts » . **Consequently, timely appraisal of these ground-water resources is important so that their development and use will enhance the region while minimizing unnecessary conflicts and preventing degradation of the resource." The maps provided on these sheets are intended to help decisionmakers address this issue.

QUATERNARY STRATIGRAPHY Figure 7 depicts the relations and current classification of sediments deposited by glacial, periglacial, and fluvial activity in east-central Illinois. The figure is based on this study and on studies by Larson and others (1979), Harsel and Johnson (1996), Herzog and others (1995), Wilson and others (1994), Kempton and Voscoky (1992), and Kempton and Others (1991). Stratigraphically from top to bottom, these sediments are couped into three major units whose distribution and thickness are portrayed in fig-roused into three major units whose distribution and thickness are portrayed in fig-res 8, 9, and 10, respectively. Figure 8 shows the interfingering Mason and Wedron roups and overlying Cahokia Formation alluvium (Wisconsin and Hudson Episodes); yes 9, shows the Glackoff Execution Alluvium (Execution III) and the Calcoling Carestian Alluvium (Provincia III) and the Carestian Alluvium (Provin Banner Formation (pre-Illinois Episode). The lower two units are se

ures 8, 9, and 10, respectively. Figure 8 shows the interfingering Mason and Wedron Groups and overlying Cahokais Formation allultuim (Wisconsin and Hudson Episodes); figure 9 shows the Glasford Formation (Illinois Episode). The lower two units are separated into two and three subunits, respectively. The distribution and thickness of the lower and middle Banner Formation subunits are significantly influenced by the configuration of the Mahomet Bedrock Valley system, which generally trends east-west across the map area, and the Maclinam Bedrock Valley in the northwestern part of the map area. These bedrock valleys system, which generally trends east-west across the map area, and the Maclinam Bedrock Valley in the northwestern part of the map area. These bedrock valleys and their tributaries are shown in figure 5. Ages of these sedimentary bundles are not precisely known, but are constrained by the following general estimates: Hudson Episode—T\$5,000 to 12,000 yBP; allinois Episode—180,000 to 125,000 yBP; all more present (yBP); Wisconsin Episode—75,000 to 12,000 yBP; allinois Episode—180,000 to 125,000 yBP; all more present (yBP); Solis referred to as the Sangamon Geosol and the Varmouth Geosol formed during interglacial episodes between the Wisconsin and Illinois glacial episodes and the Illinois and pre-Illinois glacial episodes, respectively. The units discussed in this paragraph are also shown in maps on sheets 2 and 3.

In the map area, the Wedron Group is composed of two formations, the Lemont and the Tiskilow, each composed predominantly of diamicton; two members are recognized in each formation. The Mason Group is composed of water-laid and windibown sediments subdivided into formations, members, and tongue, which occur as deposits both at the land surface and interionguing with or underlying the Wedron Group units. Within the Mason Group, the Peorio Sill (locks) is the most widespread surface unit; it caps much of the map area. The Morton Tongue of the Poorio Sill (lock) underlies the Wedron Group diamic

valleys and compose most of the fill in these valleys. The middle Banner Formation consists of the Mahomet Sand Member in the Mahomet Bedrock Valley. It is composed laint, the Sankoy Sand Member in the Makinam Bedrock Valley. It is composed mainly of outwash sand and gravel within the main bedrock valleys, but intertongues with a silf facies in the tributary valleys, and grades upward into fine-textured leaustrine with a sit facies in the industry valueys, and grades upward into line-restructed accustme sits, and locally organic-rich alluvial sit, in some areas of the main bedrock valleys. These silts were deposited in temporary lakes created by ice or sediment dams. The approximate delineation between the fluvial and lacustrine facies of the Mahomet Sand Member is shown in figures 14B and 15A (sheet 2). In most of the Mahomet Bedrock Valley, the middle Banner Formation composes the entire fill of the valley and rests on Pennsylvanian or older bedrock units; in some of the tributaries, its sllt facies overlies older deposits of the lower Banner Formation. Lower Banner Formation deposits in described in well logs and samples in various places in the Mahomet Bedrock Valley, but their distribution is patchy and they are not easily separated; therefore, for the report, lower Banner deposits in the Mahomet Bedrock Valley are included in the mid-

dle Banner Formation.

The most extensive deposits of the lower Banner Formation are found in the western confluence area of the Mahomet and Mackinaw Bedrock Valleys. In this region,
recent studies and drilling (for example, Herzog and others, 1995) have shown extensive areas containing interbedded diamictors, coarse-textured sand and gravel, and
fine-textured lacustrine sand, silt and clay beds. Although these deposits appear to be
highly variable in distribution, thickness and composition, it is possible with more data
they will become more predictable, and mappable. To the east of the map area on the
bedrock uplands, local remnants of older sediments are present and correlated mainly
with the lower Banner Formation. These deposits include the Belgium Silt Member,
which records a remnante magnetism with reversed hoarity (Kennton and others with the lower Banner Formation. These deposits include the Belgium Silt Member, which records a remanent magnetism with reversed polarity (Kempton and others, 1991). This information, along with amino-acid racemization determinations (Miller and others, 1992) made on shells collected from a gravelly clay resting on bedrock and directly below the Mahomet Sand Member close to the deepest part of the Mahomet Bedrock Valley, suggests that the age of these oldest deposits is more than 730,000 yBP.

Over many years, an extensive ISGS collection of records from wells and borings ha been used to interpret age relations and lithology for geologic mapping and ground-water studies in cooperation with local, State, and Federal partners. A cornerstone of our current effort was identifying a set of 'Key stratigraphic control points' (Kempton, 1990) from the ISOS collection of subsurface data. This collection was supplemented by data from six test holes drilled for this project, including the Gifford six shown in to the photographs. From these control points, we built a stratigraphic database. We identified 177 such bowhole records, which, if they were evenly spaced, would ware age about 1.5 per township. These data served as principal control for constructing maps of each stratigraphic until figures 11 and 12 show the locations of the control points. Only 167 control points are shown in figures 11 and 12 because 10 points

are located outside the map area.



These high-quality data points have been described in detail by ISGS geologists, and their locations have been field verified. The information is in the form of continuous core samples from test borings, drill cuttings and washed "grab" samples from water wells, geophysical logs, and, rarely, outcrops. Some drillers' logs having detailed descriptions were used in a few areas of sparse data. Samples provide an understanding of the geology at a niver site and are commonly compared to data in pearly used. ng of the geology at a given site, and are commonly compared to data in nearby well ogs to develop interpretations of the distribution of any particular geologic surface, oth areally and at depth. When integrated with geologic surfaces above and below, hese data served as principal control while we constructed a map of each stratigraphic unit. These data also were used to develop the interpretive cross sections (sheat) fig. 17), which were drawn by hand as the regional model of geologic history was devel-

oped.

Although only 177 boreholes constituted the key stratigraphic control, many more well data were used in preparation of these maps. These secondary data were helpful in refining the location of contour lines. For some stratigraphic surfaces, these secondary data were numerous; for example, 1355 boreholes were used in the construction of the bedrock-surface elevation map.



Because of the thick sequence of geologic materials in the region, and the paucity of exposures, subsurface information was a critical part of the geologic mapping project. Subsurface information formed the basis for most geologic maps of the region and for

GEOLOGIC INVESTIGATIONS SERIES MAP I-2669 (SHEET 1 OF 3)

the evolution of concepts of the geologic history of the Mahomet Bedrock Valley system and the origin of the sediment cover that incrementally buried it (for example, Horberg, 1953; Kempton and others, 1991; Herzog and others, 1995; and Larson and others, 1997). It was a primary goal of our study to build upon the findings of prior investigations, using newly refined stratigraphic data to produce updated, revised maps that could be used for various computer-aided applications such as ground-water modeling.

Another goal was to produce these maps using digital methods because, increasingly, counties, planning agencies, and other entities are using geographic information

maps that could be used for various computer-aided applications such as ground-water modeling.

Another goal was to produce these maps using digital methods because, increasingly, counties, planning agencies, and other entities are using geographic information systems (GIS) to support decisionmaking and planning. These entities need digital geologic maps information and specific information or interpretations derived from geologic maps. This derived information, combined with related scientific and socioeconomic data, can help support reasoned decisions. Commonly, this information is compiled and analyzed using GIS technology because of the large size and complexity of many map databases and the need to readily update and revise maps as new interpretations and data become available. Because computer-based mapping of deposits in three dimensions is not yet a common, well-established practice, we developed GIS-based methods to integrate point data (key stratigraphic control) and areal data (geologic mapping) in three dimensions. These methods are briefly described here and in Solier and others (1998).

Maps constructed using GIS techniques are in some ways easier to produce than conventional, hand-drawn maps. For example, map revision and generation of color proofs is done more quickly in a GIS. For other needs, however, conventional mapping can be easier and less time consuming. For example, consider an area having thin, discontinuous units. While creating a hand-drawn set of maps showing elevation of the top of each unit, the geologist will attempt to ensure, visually, that a unit's elevation contour lines do not conflict with those of overlying and underlying units (so that, for example, the elevation of a lower unit does not surpass an upper unit). In so doing, the geologist produces an internally consistent, three-dimensional geologic model and set of maps for a region.

With GIS techniques, maps are proceeded that are similar in appearance to handrawn maps; to the eye, each elevation map may appear not to c

Creating a vector map Figures 13-16 (sheet 2) present for each of five primary Quaternary stratigraphic Figures 13–16 (sheet 2) present for each of five primary Quaternary stratigraphic units and two minor sand layers a block diagram (three-dimensional perspective view) showing topography of the upper surface, an elevation map of the upper surface, and a thickness map. A block diagram and an elevation map of the bedrock surface are also shown. Our mapping of each stratigraphic unit was an iterative process that, through re-examination of stratigraphic data and maps, gradually refined our understanding of the vertical and lateral distribution of each unit. To map a unit, we first plotted the stratigraphic control data, then prepared a hand-contoured map based on the data and on an understanding of the regional distribution of the materials and geologic history (for example, the middle Banner Formation had a glaciofivation drigin and was confined to bedrock valleys). The map was then scanned and a vector map of the linework was created.

Converting to raster format

A vector map generally is a faithful rendition of a hand-drawn contour map. For example, each vector, or line, on an elevation map of the upper surface of the middle Banner Formation has an elevation value (for example, the 475 or 500-foot elevation contour). Areas between contour lines possess a range of elevation (for example, between 475 on 4500-ft) and the elevation at any location on the map fother than on a contour line itselfi cannot be more precisely defined. Although such values may be inferred by interpolation, they are not explicitly defined. A traster map, however, depicts information at each of many regularly spaced grid cells. It contains more information than a vector map, because it also provides an estimated or interpolated value between data points and contour lines. Computer-generated cross-sections, three-dimensional visualizations, and many modeling routines (for example, for ground-water flow) require raster data.

Data on the vector map were processed to a raster format. Although useful for analysis, raster maps can appear somewhat different from vector maps, because they tend to show the map information with a blocky or jagged appearance rather than the smoothly drawn boundaries to which we are accustomed. For example, refer to the northeast corner of figure 15B (sheet 2), specifically the areas classified as 25–50 and to 150–75 ft thick. There, a jagged contact is displayed because each raster data point, which varies by as little as one foot from its neighbor, has been assigned to an elevation category. This has been done purely to ali in visual comprehension—the continuous data on a raster map are force-fit into an interval classification, which is more appropriate to vector maps, Jagged contacts, while they may appear to signify errors or inconsistencies on our maps, actually connote very small changes in elevation (for example, values on either side of the jagged 50-foot contour in the northeast corner of figure 15B vary by only a foot or so). In contras

An internally consistent geologic model and set of maps

An internally consistent geologic model and set of maps

After each elevation map was rasterized, it was compared to the stratigraphic control data and to the elevation maps of stratigraphic units above and below it. This was the first stage of an iterative process of re-evaluating stratigraphic interpretations in the database and refining the maps. In many cases, interpreting the stratigraphy was difficult because units of distinctly different ages and different depths looked the same. For example, in test borings that sample multiple diamictons, upper Banner Formation diamictons can be misidentified as lower Glasford Formation due to their similar appearance, especially if intervening soils are not present. If the elevation of a stratigraphic unit at a particular point was anomalously higher than appropriate, based on the regional geologic map trend, it was re-examined for a potentially better fit with an overlying map unit. In some cases, the lithologic characteristics of the sample were inconclusive and the stratigraphy was found to be correct and diagnostic of the lower unit. In the latter case, a shortcoming of the regional mapping is indicated: the anomalously high data point was correct and represented some local relief that was not mappable at our scale. Those map data were retained, and the resulting local "spike" in the map surface indicates a need to gather more information for that area. This situation occurs near the southeast correct of the map area shown in figures 13D and & (sheet 2); there, a small topographic high corresponds to a key stratigraphic control point. Only with extraordinary efforts to collect significantly more data could the fine detail around the data point be mapped.

Discontinuous units are particularly difficult to map because gridding algorithms compute cell values by interpolation methods. [We used the Arc/Info Topogrid algorithms to the season of the control point of the season of the control point of the season.

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Discontinuous units are particularly difficult to map because gridding algorithms compute cell values by interpolation methods. [We used the Arc/Info Topogrid algorithms; for these data, we found that other algorithms supplied in Arc/Info and in other software provided results less appropriate to our needs.] No algorithm can produce a real-site map where data are absent across areas of relatively high relief. Consider, for example, the middle Banner Formation, which is confined to valleys separated by expanses of upland. A gridding algorithm must compute a value for every cell, including those far removed from data points, and each cell's value depends in some measure on adjacent cells. Unrealistic cell values that greatly departed from values on the vector map (sepscially in topographically list areas and near large changes in slope gradients). 2] re-gridding the map, and 3] removing upland-area data from the raster map because, as noted above, the middle Banner Formation does not occur on the uplands). This method is useful for units whose depositional pattern is predictable. For the basal sands of the Clasford Formation (sheet 2, fig. 16), data are sparse and the unit's distribution is not so predictable. There, we gridded the unit thickness data and computed the elevation of the unper surface by adding unit thickness to the elevation of the underlying unit.

computed the elevation of the upper surface by adding unit thickness to the elevation of the underlying unit.

Comparison of maps for each layer revealed potential inconsistencies such as areas where an older, lower unit was mapped at a higher elevation than the unit above. For example, the initial raster map of the upper Banner Formation was computed without considering the topography of underlying units. Comparison of bedrock and upper-Banner elevation maps revealed the control that bedrock topography imposes on the distribution of upper Banner deposits. Revision of contour lines and re-gridding produced a map showing the correct spatial relation—progressive thinning and then absence of upper Banner Formation, from the valley to the bedrock uplands. Refinement of the map of each stratigraphic unit proceeded in this fashion until an internally consistent stack of maps was created.

Internal consistency between the elevation map of the Wedron and Mason Groups and the elevation map of the upper Glasford Formation (sheet 2, figs. 14E and F) was and the elevation map of the upper Glasford Formation (sheet 2, figs. 14E and F) was

Refinement of the map of each stratigraphic unit proceeded in this fashion until an Internally consistent stack of maps was created.

Internal consistency between the elevation map of the Wedron and Mason Groups and the elevation map of the upper Glasford Formation (sheet 2, figs. 14E and F) was difficult to achieve, especially in the southwestern part of the map area at the limit of Wisconsin ice, where thick Wedron Group end-morainal deposits abut an area underlain by outwesh, alluvium, and loses of the Mason Group and Cahokia Formation sheet 2, fig. 15E). There, Mason Group deposits and Cahokia Formation are in places thick, thin, or absent; all overlie upper Glasford Formation deposits, which are in places exposed. Considering the thin, discontinuous nature of the overlying deposits in that area, the upper Glasford Formation reasonably could be mapped at the land surface. However, joining the complex land-surface topography with the far more generalized contours of the buried upper Glasford Formation surface to the north and east, under the Wedron Group end moraine, and then integrating that composite surface with the map of the overlying unit (Wedron and Mason Groupp did not give satisfactory results. The fine topographic detail southwest of the end moraine could not readily be meshed with the coarser, less detailed contour data on the upper Glasford surface under the end moraine. Attempts to mesh the contours were unsuccessful, resulting in abrupt topographic breaks across the toe of the end moraine. These breaks could be corrected, mostly through editing of individual cells or pixels. It was decided not to do so, because of the time and effort needed and because the corrections would produce a map that could not readily be updated or revised during development of the integrate geologic model and set of maps. Also, future revisions to the map by the process described above (that is, revisions to the vector map and re-gridding) could not be made if the raster map were extensively edited. Thure revisions to

defined units. With a complete set of elevation maps generated, maps of unit thickness were then computed, by calculating the difference in elevation between the top of the unit and the top of the underlying unit. Because these thickness maps are derived from two rester elevation maps, they reflect characteristics of each parent map. Consequently, when displayed as interval rather than continuous data, they tend to show more of the characteristic lagged appearance of raster maps than do the elevation maps. As discussed above, these are not mapping errors. VISUALIZING THE DEPOSITS IN THREE DIMENSIONS

Geologists have traditionally used cross sections and fence diagrams to visualize geologic units in three dimensions. Portraying the three-dimensional nature of geologic materials in a much detail as possible is essential to an improved understanding of geologic maps and geologic processes responsible for the distribution of deposits. This information is needed both during the iterative process of mapping and for the public's comprehension of map information. The three-dimensional visualization products lic's comprehension of map information. The three-dimensional visualization products we provide here were developed in EarthVision software, from two-dimensional grids of each strattgraphic horizon created in Arc/Info. They include block diagram perspective views of each strattgraphic horizon (sheet 2, figs. 13 and 16C and P) and the fence diagram and horizontial 'slices' on sheet 3 (figs. 18 and 19).

Traditional methods of showing changes in subsurface-unit geometry along a vertical plane (cross sections; see fig. 17 on sheet 3) and providing a three-dimensional perspective of these planar views (fence diagram; see fig. 18 on sheet 3) are useful for illustrating the configuration of the Mahomett Bedrock Valley and progressive valley infilling. Cross sections may be selected to emphasize a particular feature, such as unit thickness along the length of the Mahomett Bedrock Valley at its thalweg, or deepest point (see cross-section J-J' on sheet 3).

Computer software provides the opportunity to easily manipulate data in order to

point (see cross-section J-J' on sheet 3).

Computer software provides the opportunity to easily manipulate data in order to quickly view and evaluate subsurface deposits as maps are iteratively being developed. Software also allows the geologist to view and evaluate the deposits from more prespectives than would be efficient using traditional cartographic methods. For example, figure 19 on sheet 3 shows the pattern of units that would be seen along a horizontal plane at a given elevation if overlying deposits were removed. Starting with the lowest plane, this series of images shows the gradual infilling of the Mahomet Bedrock Valley, and may suggest the persistence of this feature throughout the section. When displayed on the computer as an animation, this series of maps provides a new, dynamic visualization of the distribution of deposits through time. Computer-based, three-dimensional visualization offers a significant new opportunity for a more complete understanding of subsurface glaciogenic sediments, both to the geologist and to other map users.

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